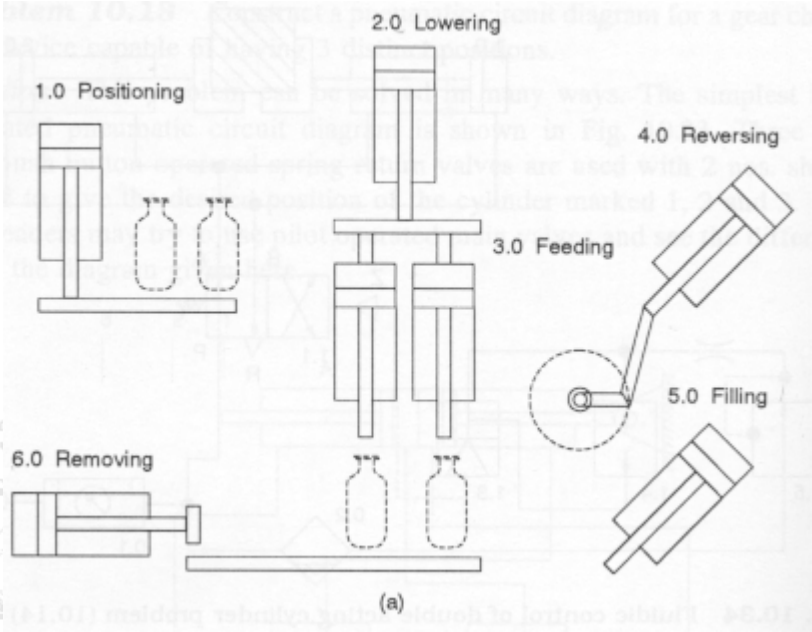
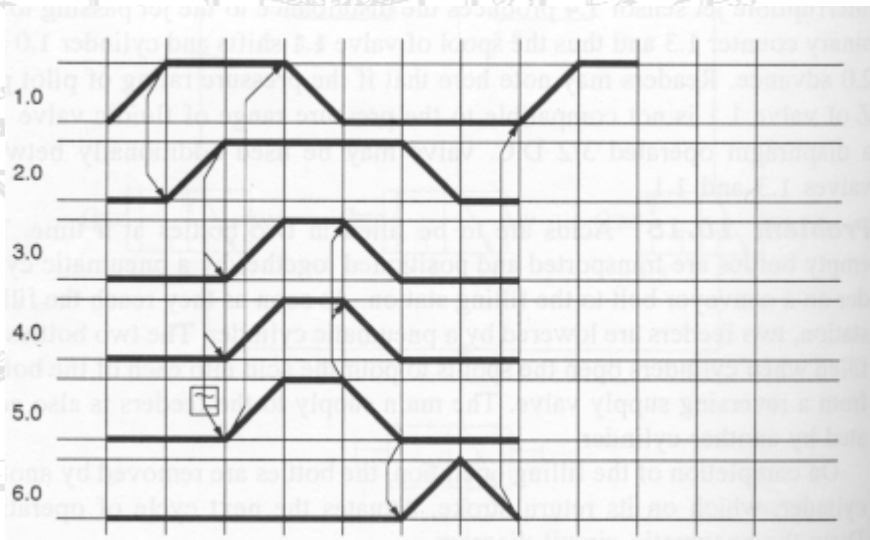
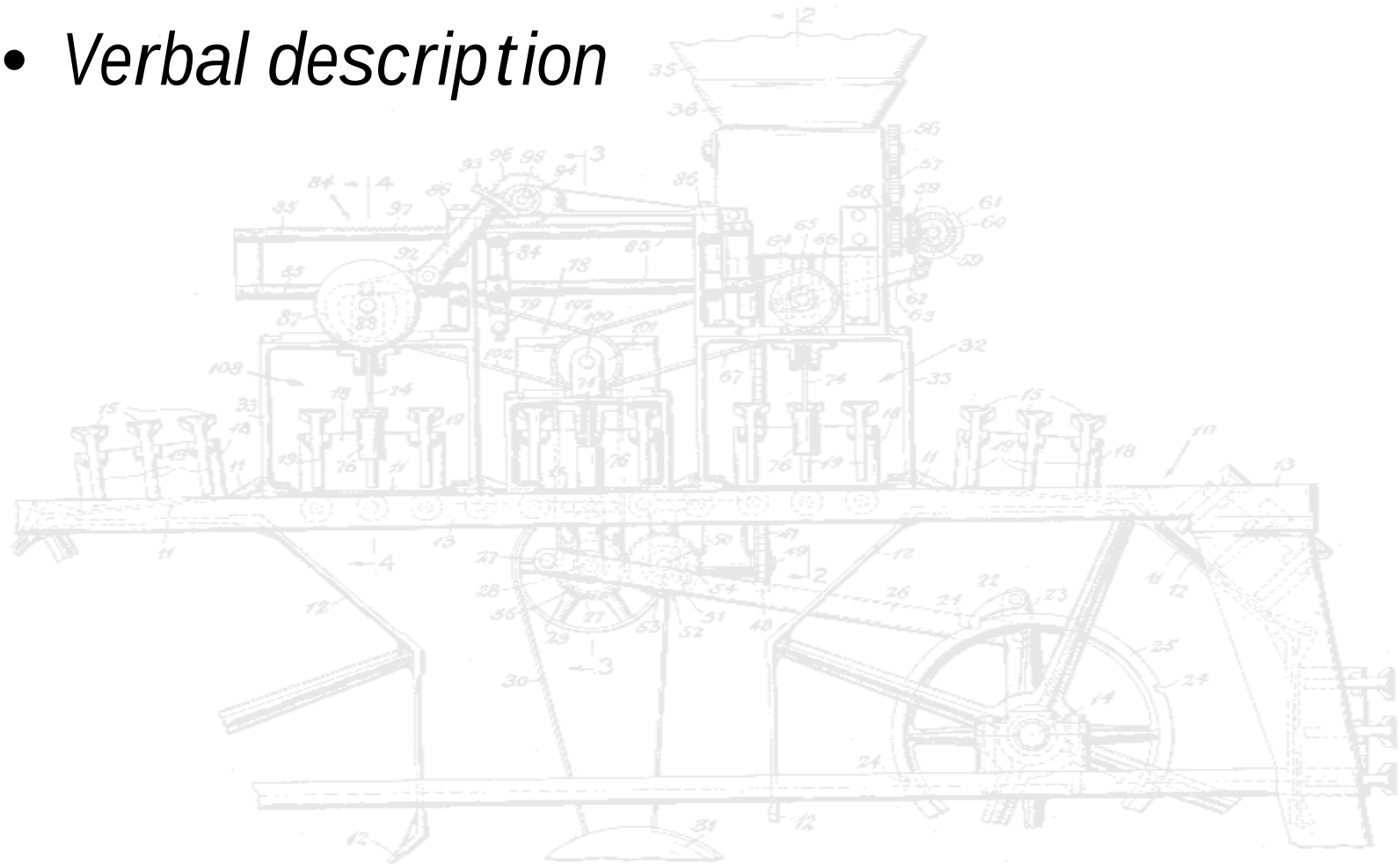
Timing Diagrams



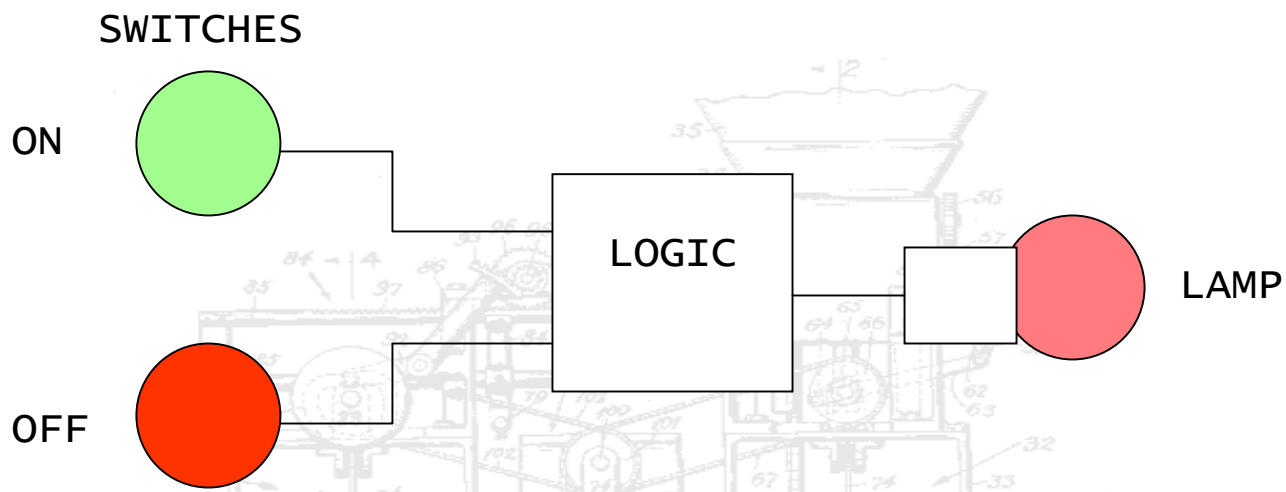


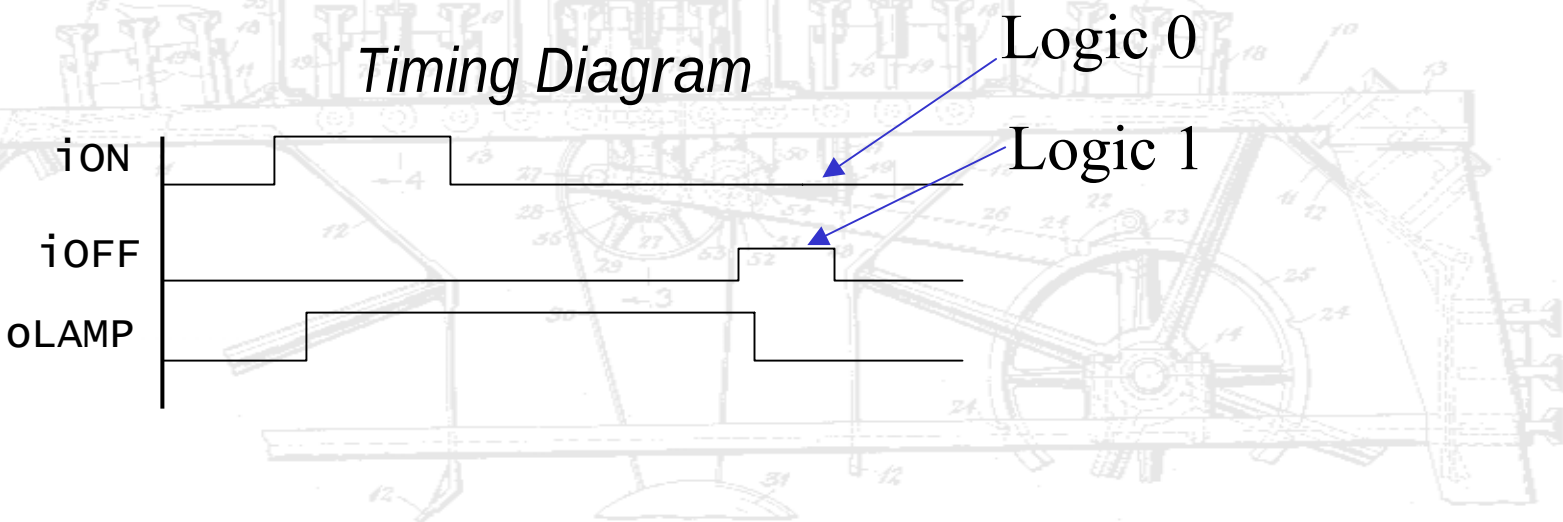
State Machines

- *Flow charts*
- *State diagrams*
- *Verbal description*

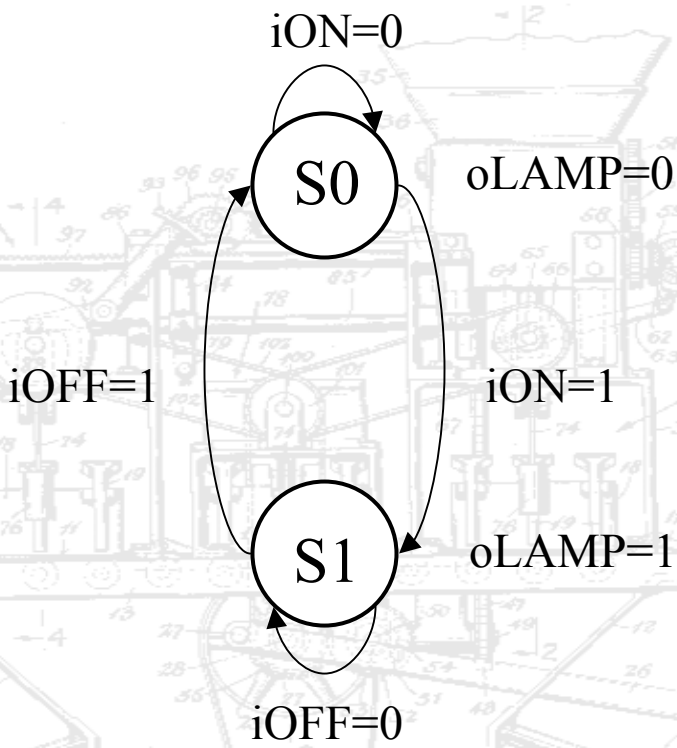


The Simplest State Machine

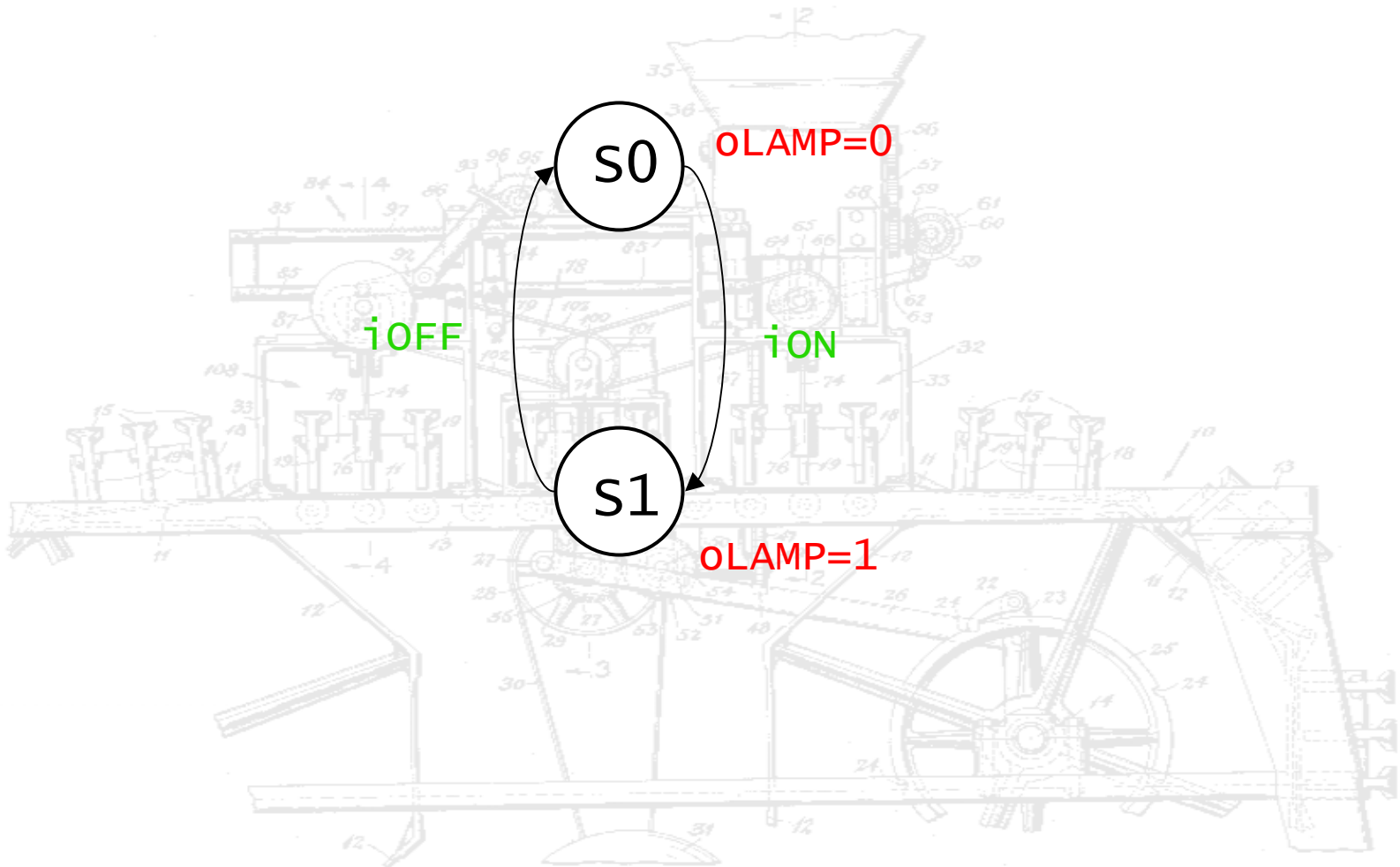




The Simplest State Machine

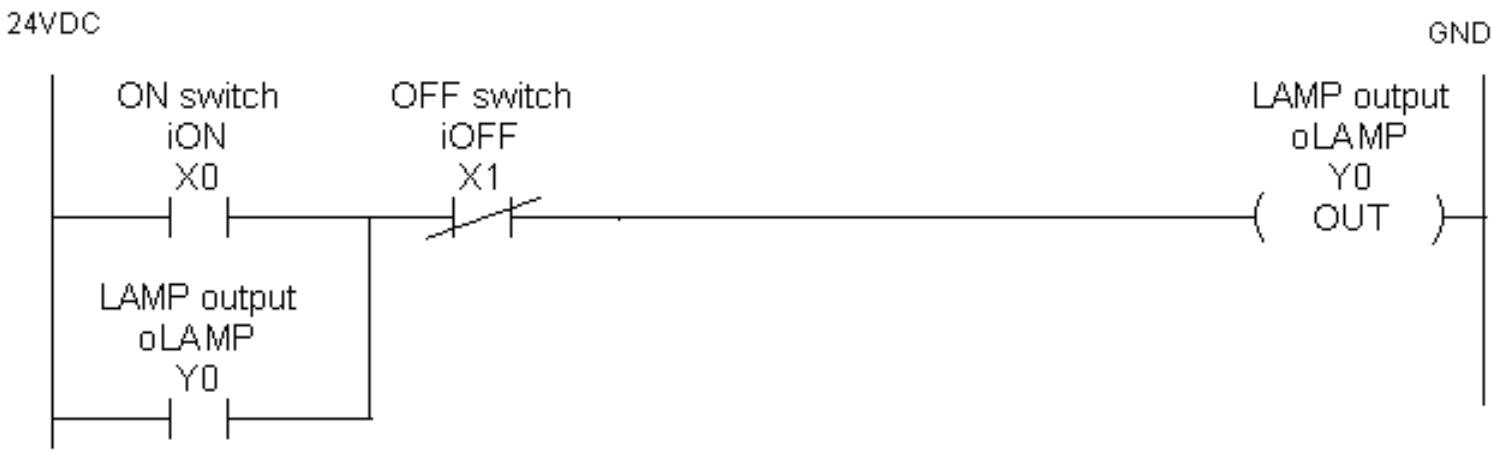


Simplest State Machine

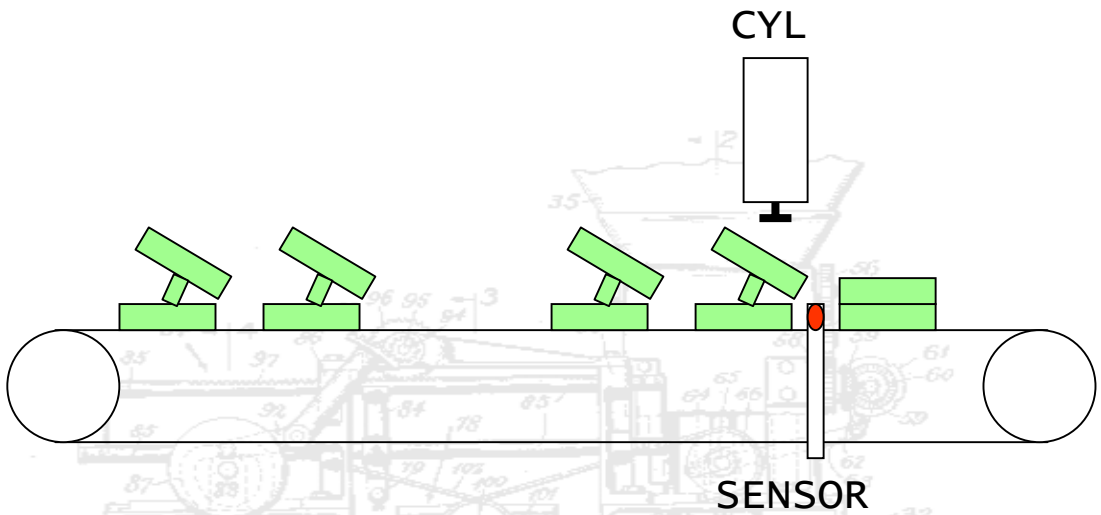


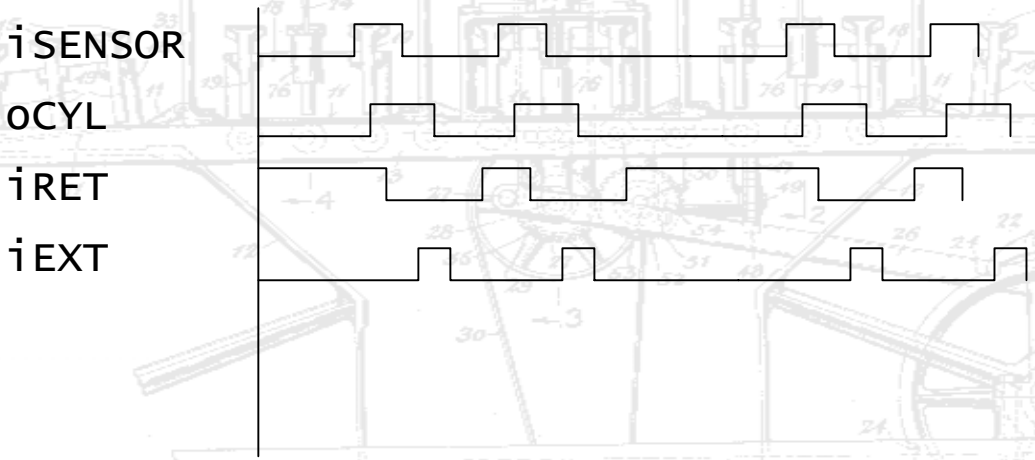
Logic Eq. & Ladder Diagram

oLAMP = /iOFF•(iON + oLAMP)

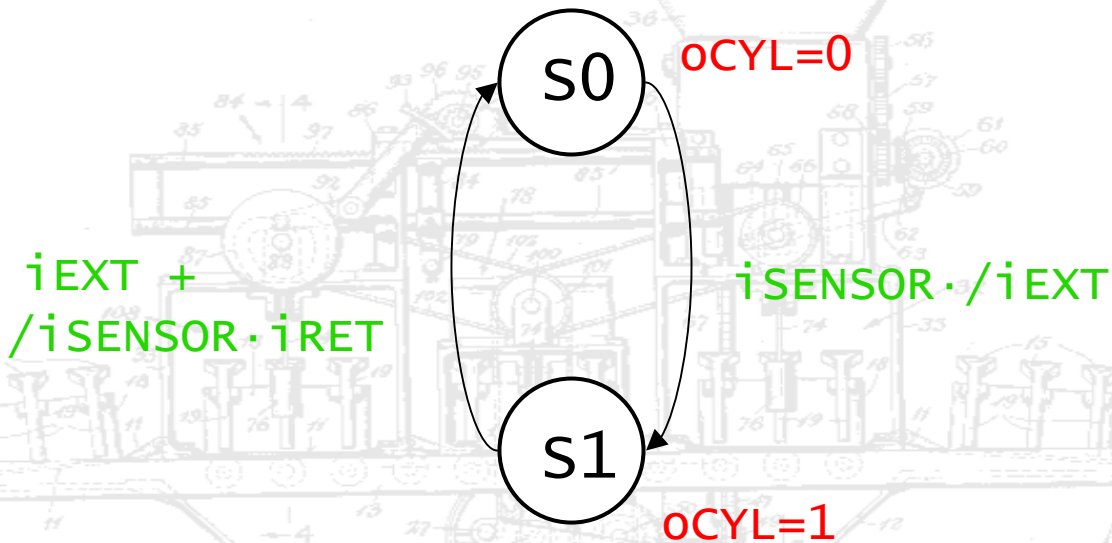


Another Example



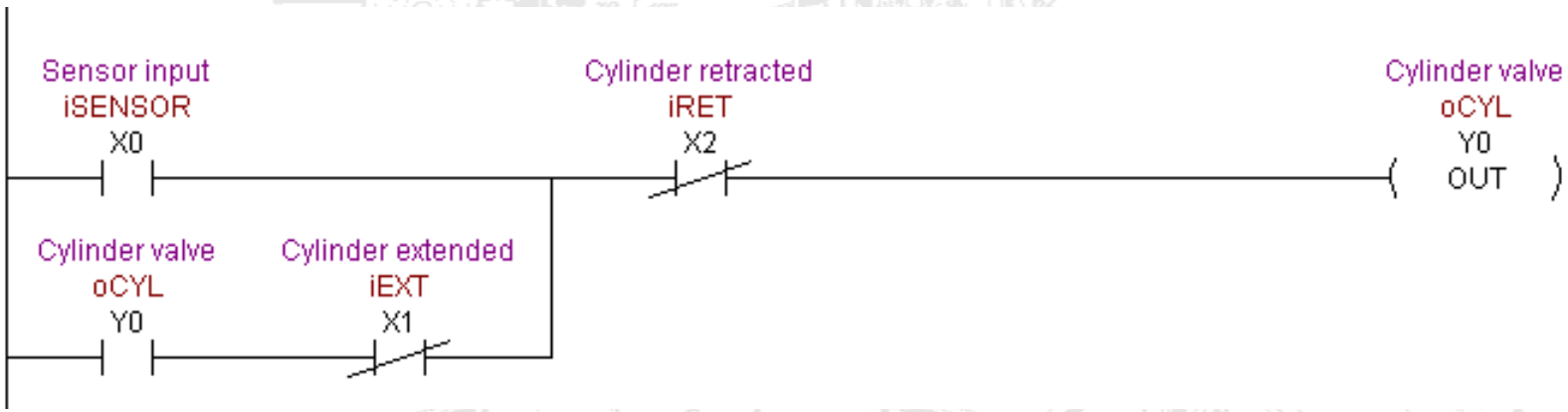


Example#2 State Diagram

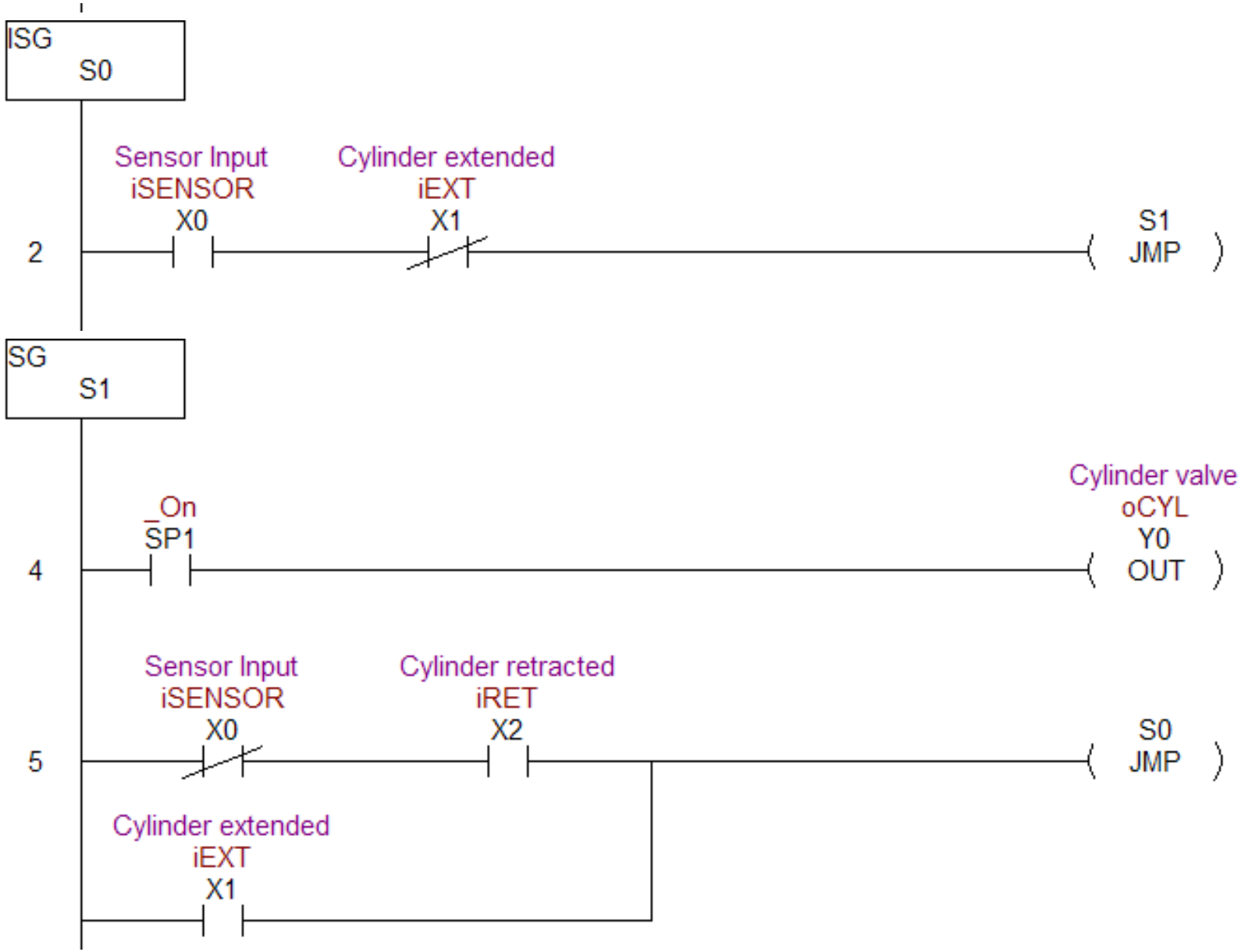


Example#2 Ladder Logic

$$oCYL = iSENSOR \cdot /iRET$$
$$+ /iRET \cdot /iEXT \cdot oCYL$$
$$= (iSENSOR + /iEXT \cdot oCYL) \cdot /iRET$$



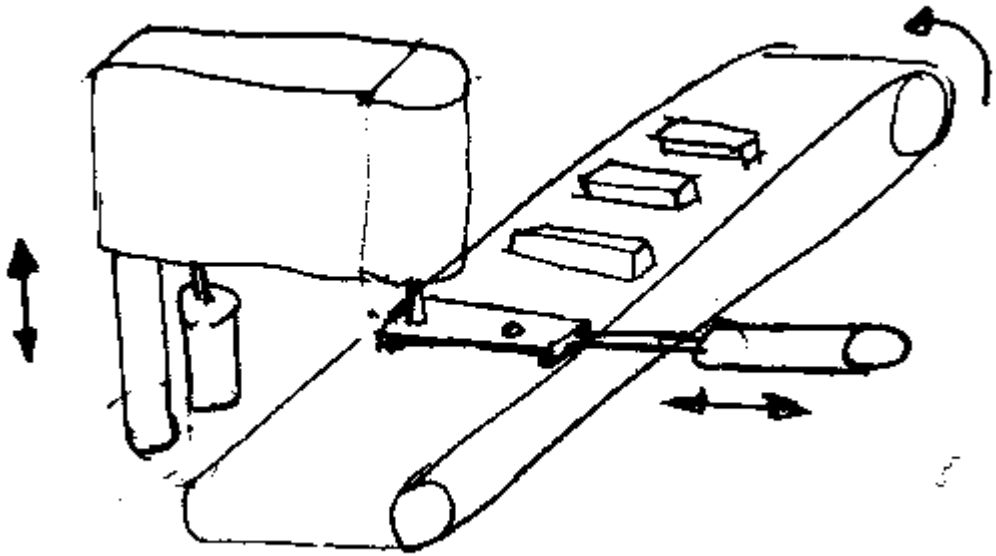
Example#2 Ladder Logic - Stages



State Machines in ladder Logic

- *Pure relay logic - traditional design:*
  - *2 states = 1 coil*
  - *3-4 states = 2 coils*
  - *5-8 states = 3 coils, etc.*
  - *difficult to debug or modify*
  - *difficult to document*
- *Pure relay logic - "one-hot" design*
  - *1 coil per state*
  - *easier to debug and modify*
- *RLL-Plus*
  - *"Stages"*
  - *JMP "coils"*
  - *easiest to write and maintain*
  - *not available in all brands of PLC*

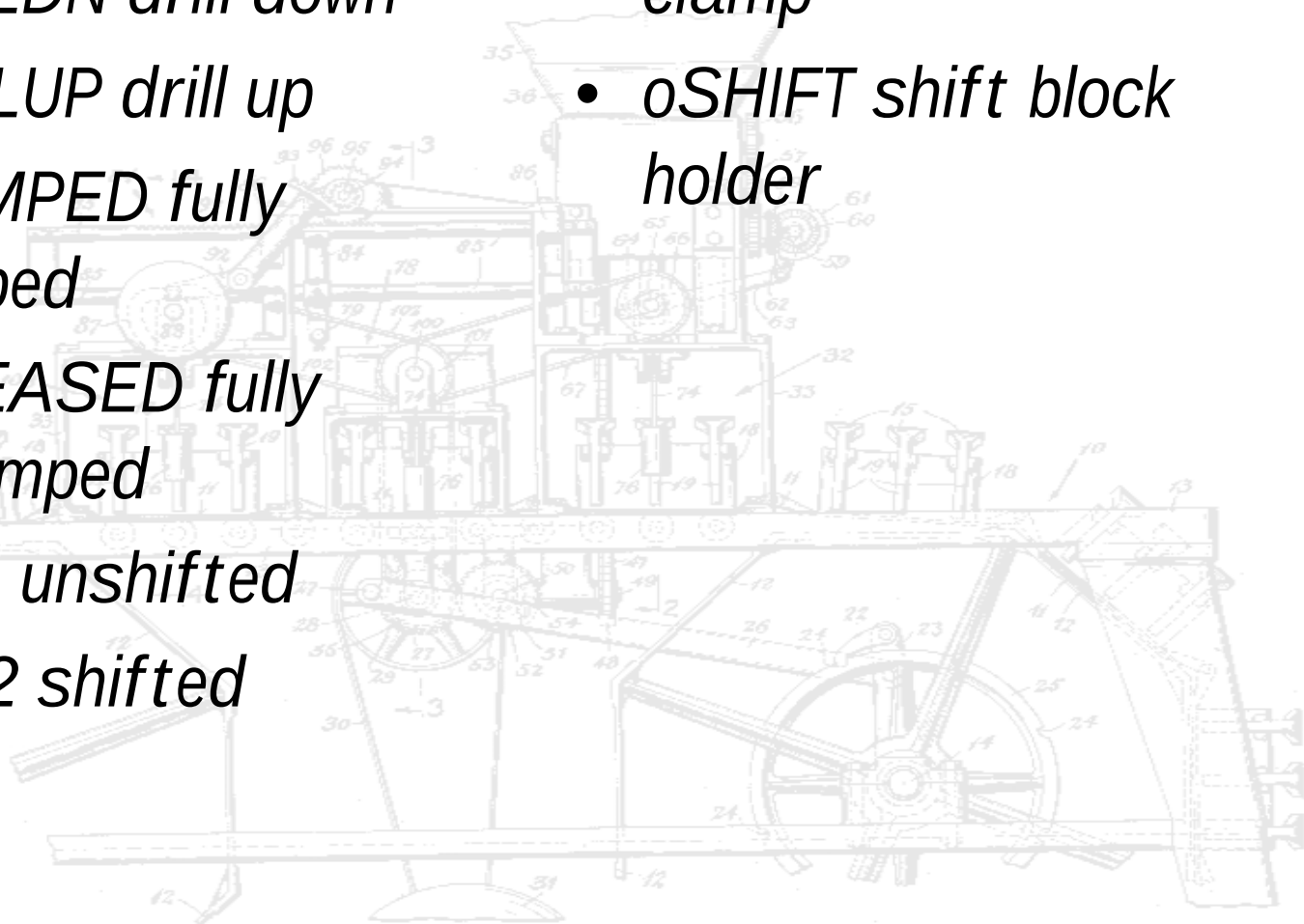
Multi-State Example



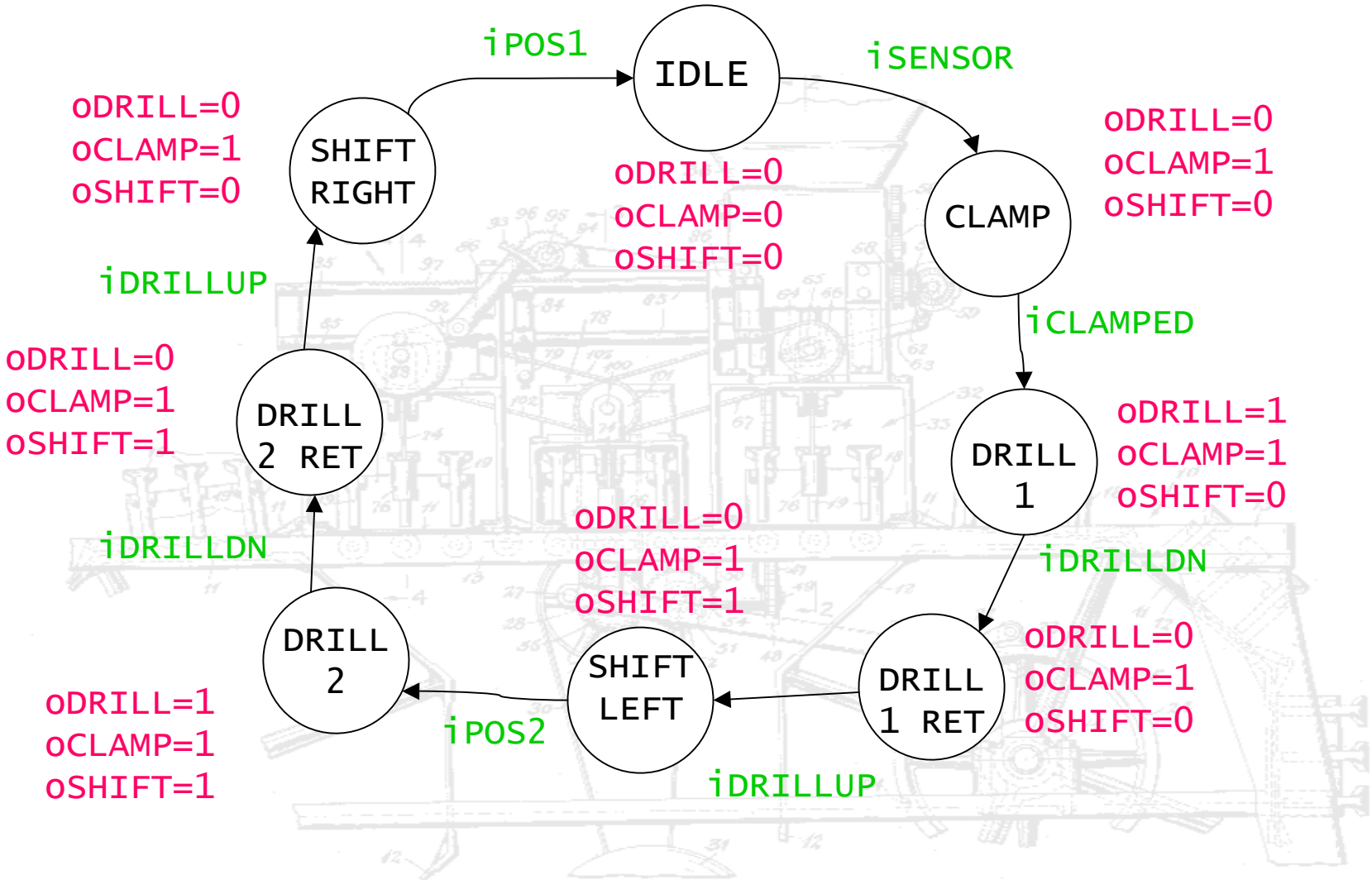
When sensor detects block; clamp block, drill hole, shift, drill 2nd hole, shift back, release clamp.

Inputs & Outputs

- *iSENSOR block present*
- *iDRILLDN drill down*
- *iDRILLUP drill up*
- *iCLAMPED fully clamped*
- *iRELEASED fully unclamped*
- *iPOS1 unshifted*
- *iPOS2 shifted*
- *oDRILL start drilling*
- *oCLAMP activate clamp*
- *oSHIFT shift block holder*



State Diagram



Stage Ladder Logic